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The Aftermath

Since the inception of the crisis, the radio has informed the world each day that quantities of coal have been " saved." There is to be implied from such statements that something has been put by for future use. This is not true; the fuel " saved " is like last month's unused sweet ration coupons. The value of fuel, like the sweet coupons, lies in its availability for immediate use.

Thus the majority of foundries can regard the great switch-off as an irrecoverable loss. All that can be placed on the credit side is a lesson in the new economy. There is too little realisation that all pre-war theories—and there were many—were based on large raw material and man-power reserves, neither of which exist to-day; nor are they within measurable sight.

Thus the whole future planning of industry must assume a new aspect. Closer scrutiny must be given to the availability of power, raw materials and man-power. The new conditions certainly stress the need for an intensive recruitment campaign, and improved amenities in the heavy industries. Enterprise should be directed towards increasing the quantities of raw materials and tools for their winning, preparation and distribution.

Industries ceaselessly making apparatus, the use of which will impose extra loads on power stations will need to pay attention to political tendencies, as future inhibitions may make their sales impossible. There is almost certain to be some correlation made between power station capacity and output of electrical machinery and gadgets.

There will be a great demand for mining machinery and power generating plant and foundries manufacturing castings for these industries must be given first priority. There will also have to be a revision of the notions as to how best to equip the houses now being built to rehouse the population. All-electric houses no longer appeal to housewives, when there is a prospect of only intermittent availability of current. Means will have to be found of stepping up coal production and its more efficient preparation and distribution, even if this involves the use of foreign labour. The provision of the most suitable fuel for the job would do much to improve production.

It will be difficult to restart industry, as the general shut-down will result in all sorts of shortages and late delivery of raw materials, and advantage might usefully be taken of a somewhat early spring-clean, by utilising redundant labour. Actually, many foundries during the crisis have maintained their full staff doing odd jobs.

The Government have announced their intention to stagger the hours of working in industry, involving the creation of night shifts. This should not affect the jobbing foundries, as they use but relatively little current; the mechanised shops, however, are likely to be subjected to staggering.

A bad mistake has been made through lack of foresight by the Government, and it is generally recognised that the ban on production of the technical Press was a first-class blunder. To overcome the present crisis, reliance has to be placed on the country's technicians, yet, in their panic, the first step made by the Government was to deprive this important section of the community of its specialised Press.

In our case, a continuity of 45 years has been broken—a fact which all our readers will regret and for which we offer our sincere apologies.

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FORTHCOMING EVENTS

(Secretaries are invited to send in notices of meetings, etc., for inclusion in this column.)

MARCH 4-29

Ideal Home Exhibition at Olympia. Open 10 a.m. to 10 p.m. each week-day.

MARCH 7.

King's College London Engineering Society :—Centenary Celebration Dinner at Savoy Hotel at 7.15.

Manchester Association of Engineers :—" Handling of Raw Materials in Large Engineering Works," by W. L. Beeby and W. Symes. At 17, Albert Square, Manchester, at 6.45 p.m.

Sheffield Society of Engineers and Metallurgists :—Dinner at Royal Victoria Station Hotel, Sheffield.

MARCH 13.

Institute of Metals :—" Manufacture of Seamless Steel Tubes," by Dr. J. W. Jenkins. At 4, Grosvenor Gardens, London, S.W.1, at 7 p.m.

Institute of British Foundrymen

MARCH 8.

West Yorks Branch :—" Wood and Metal Patternmaking," by W. C. Perry. At Technical College, Bradford, at 6.30 p.m.

NOTES FROM THE BRANCHES

WALES AND MONMOUTH

On Saturday, January 25, Mr. F. H. Smith, Development Officer of Alar, Limited, addressed a meeting on " Secondary Aluminium Casting Alloys."

Prior to the meeting, members had visited the foundry of Dialoy, Limited, which is equipped solely for die-casting. An interesting time was spent viewing the foundry and recently produced castings. Actual production had been suspended at mid-day, but Mr. Williams and members of the staff explained every process so fully that this handicap was overcome. The lighting-up of the gas-fired Skelnar furnace was demonstrated.

The company adjourned for tea at the Engineers' Institute at the invitation of the management of Dialoy, Limited, following which Mr. Smith presented his Paper, accompanied by a series of lantern slides. A general discussion followed.

Mr. Hiram Williams moved and Mr. Duddridge seconded a vote of thanks for an interesting lecture which would be of considerable value to those engaged in the casting of light alloys. This was carried with acclamation.

In reply, Mr. Smith regretted that time was not adequate to cover the whole field of light alloy casting. To sum up, the way to sucess was in the choice of the right alloy for the job, and the operation of the correct casting technique in production.

SOUTH AFRICA.—At a meeting held in Johannesburg on November 28, presided over by Mr. J. H. West, vice-president of the Branch, in the unavoidable absence of Col. Grose, Mr. T. E. Bentley delivered an address on " Industrial Design and Its Place in Modern Industry." After reviewing the history of the subject, the lecturer gave several examples of modern trends and terminated by detailing the advantages to be gained through the use of coloured paints in workshops. Following the Paper, Mr. A. B. Bill, who took a major part in the discussion, was presented with the Institute diploma for a Paper he read before the East Midlands Branch last session.

CORRESPONDENCE

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

To the Editor of the FOUNDRY TRADE JOURNAL.

ROLLING OF CAST IRON

SIR,—Piwowarski's article reminded me that about 30 years ago I experimented for some months with the rolling of various hard and so-called " non-forgeable " alloys. I am afraid, however, I would not have accepted a reduction of 78 per cent. in eleven passes, with a re-heat of three minutes before each re-roll, as hot rolling. My experiments were carried out in a rod mill but, unfortunately, it is so long ago I have only a vague idea of the roll diameter and no idea of the rolling speed, but can only say it was the standard speed used in Sheffield for the rolling of mining drill steel and the like.

I was really only interested in trying to roll a nickel chromium alloy containing 7½ per cent. aluminium, which in the cold had a Brinell hardness in the vicinity of 600. I did, however, also experiment with the various pig irons that were available in a crucible steel works and by a particular technique was able to roll bars up to fifteen to twenty feet long. The procedure was, however, rather unusual.

A small furnace was built alongside the rolls and the metal was cast into thin-walled, mild steel tubes surrounded by kieselguhr. The tubes were sometimes square and sometimes round, and were either two inches square or two inches diameter. All the alloys were cast rather hot, and, due to the insulating effect of the kieselguhr, cooled rather slowly and uniformly. They were passed through the rolls when the temperature was in the vicinity of 1,000 deg. C., and in practically every case rolled without difficulty.

After rolling there was, of course, considerable difficulty in removing the mild steel casing. The only thing that I can now definitely remember about the experiments with pig iron is that, whilst usually the material used was white iron, after rolling it was no longer white. I would, however, hesitate to say that it was " grey."

One point that many metallurgists seem to overlook is that it is quite easy to forge and hot roll high carbon alloys if the chromium is sufficiently high. The silicon should not be less than 0.5 per cent. At one time one of the most popular die steels contained approximately 2.5 per cent. C, and Cr 15 per cent., and I have been associated with the manufacture of hundreds of tons of it. It was cast in various-sized ingots from 3 in. square up to 12 in. square, depending upon the finished cross section required. No difficulty was ever experienced in rolling such material down to ¼ in. round but the rolling of sheets was not economical. Steel containing C 1.6 per cent. and Cr 12/14 can, however, be rolled into sheets.

Yours, etc.,

J. FERDINAND KAYSER.

Gillette Industries, Limited, Isleworth

Theory and Practice of The Aluminium Sand Foundry*

Present-day Rôle of The Metallurgist

By F. Raybould, A.I.M.

Reference has been made frequently in the technical Press and at meetings of the Institute of British Foundrymen to the value and importance of technical control of foundry work. At times one feels that such control is spoken of as if it were a service laid on like gas or electricity, or a new piece of plant which may be purchased and put to work in a corner of the works known as the laboratory. There is no need to emphasise that this is a misconception.

It is generally recognised that laboratory facilities are a great asset, but these should consist of far more than the compulsory chemical analysing and mechanical testing as imposed by an inspecting authority such as the Admiralty, War Office or A.I.D. Yet even now it is surprising how frequently one hears the comment: "Yes, we have a laboratory, but it does not have anything to do with the foundry." More often than not this is not due to apathy on the part of the laboratory or that its services are superfluous to the foundry requirements, but more the lack of a liaison system between the two. All foundry personnel must at some time or other have felt the need for expert technical guidance, but no matter how competent the technician may be on theoretical grounds, he will fail in his duty to the foundry if he is not fully conversant with all the practical aspects of the case. In other words, the foundry metallurgist must co-ordinate theoretical reasoning and laboratory examinations with practical observations on the foundry floor. At one time the foundryman regarded the technician's interest in his work as an intrusion to be resented as such. To-day little of this suspicion remains, and both parties have proved the advantage of co-operation.

FIG. 1—CLAY CONTENT OF NATURALLY-BONDED SANDS. FROM LEFT TO RIGHT:—SOUTHAMPTON (17 PER CENT.); MANSFIELD (10 PER CENT.); BRAMSCOTE (8 PER CENT.); AND RYARSH (2 PER CENT.).

This aspect of technical control will be brought into relief by the citing of a few simple examples of the wide range of work involved in a light alloy foundry. These examples are not chosen to stress complex theories or clever bits of foundrywork, but to illustrate direct application of technical theory to practical foundry operations.

Moulding Sands

Commencing on the foundry floor the moulding sand for aluminium casting provides the scope for endless theoretical reasoning and practical experiment. Until comparatively recent times the moulder was his own judge and jury on matters concerning moulding sand,

*A Paper read before the London branch of the Institute of British Foundrymen, Mr. G. R. Webster presiding. The Author is chief metallurgist, Foundry Division, High Duty Alloys, Limited.

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and nowadays, even with all modern sand testing equipment and sand processing machinery available, the technician who is responsible for technical control of this important branch of foundry procedure feels the need for frequent liaison with the experienced moulder

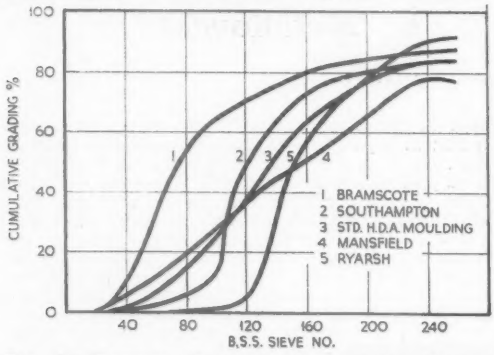

FIG. 2.—FINENESS GRADING OF NATURALLY BONDED SANDS.

to obtain his assessment of the quality of the sand he has to use. In the smaller foundries, where each moulder tended his own particular heap of sand, he developed his own rule-of-thumb methods, and no doubt became almost as skilled in that direction as in his actual moulding.

As foundries increased in size and in equipment, many installed sand distribution machinery by which the sand is milled in a central plant and supplied ready for use. This, of course, has the advantage that the sand is more uniform during the shift and from day to day. Additions of new sand and water can be controlled, but just as different types of sand are required for different alloys, so different grades of sand are preferable for different types of castings even in the same alloy. For example, for a small machine-moulded component of thin section, surface finish may be the principal requirement, whilst a heavy floor job being made a few yards away requires a sand in which the surface finish may be sacrificed somewhat so as to produce a casting free from blowholes. Thus, in a general-purpose foundry the properties of the moulding sand issued from a central processing plant will have to be a compromise between the various requirements of the foundry floor.

There are many natural moulding sands in this country suitable for aluminium sand casting, but the physical characteristics of these vary considerably, and no one sand appears to satisfy all conditions as regards strength, permeability and grain size, so that it is frequently necessary to blend one or more sands together to obtain the best results.

Fig. 1 illustrates the amount of clay in various natural bonded sands available for light alloy foundry work, and Fig. 2 shows graphs of cumulative grading of different sands. There are, however, other important characteristics of moulding sands which are not catered for by the tests shown. One is the liability of the sand to "scabbing" or "buckling." To some extent this is a function of the strength of the sand, but it is largely a question of expansion. The silica grains expand when heated by the molten metal in the mould, whereas the clay constituent contracts. The clay content, therefore, and the extent to which it is bonded with the silica grains has an important bearing upon how the sand will behave at casting temperatures. For example, some natural moulding sands are extremely effective for facing when they are used in their natural condition.

As received from the pit, much of the clay exists as nodules not bonded with the silica grains, and these unbonded clay lumps permit the easy expansion of the mould surface, so preventing buckling. Difficulties, however, arise when this sand is passed through the sand processing plant and becomes milled, for then the green bond strength of the sand rises beyond that which is satisfactory for adequate flowability and even ramming. In Fig. 3 is seen the effect of shock-testing standard test specimens of a sand consisting of large quantities of unmixed clay (A), and a sand of nigh clay content which has been thoroughly milled (B).

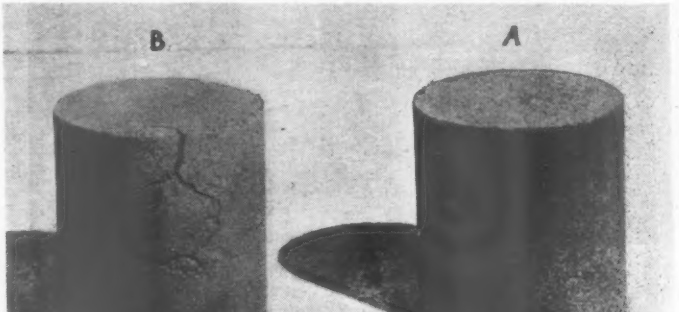

FIG. 3.—EFFECT OF SHOCK TESTING. (A)—UNMIXED CLAY; (B) THOROUGHLY MILLED HIGH CLAY CONTENT SAND.

The extent to which sand mixtures can be standardised to a pre-determined recipe is limited, especially as the desired result is to a large extent a compromise between the various types of castings to be made. The quantity of new sand replacement is usually that amount required to replace losses and keep up the bulk in use throughout the foundry. In the foundry with which the Author is associated it is the

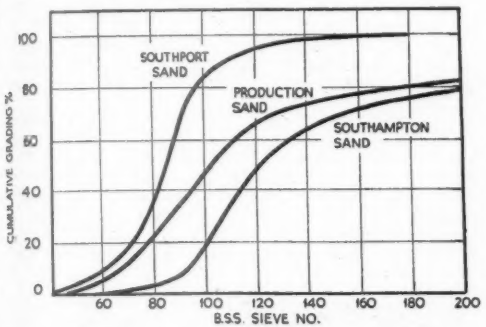

FIG. 4.—DISTRIBUTION OF GRAIN SIZE IN TYPICAL MOULDING SANDS.

practice to use a natural bonded sand, like Southampton, and blend it with sufficient silica sand, such as Southport, to reduce the clay content to about 8 per cent., giving a green bond strength of 7 to 8 lb. per sq. in. Close attention, however, to daily routine tests is necessary, so that the proportions can be adjusted as required. The graphs in Fig. 4 give an indication as to how the grain size of production moulding sand may be maintained between that of the two constituent sands used in its make-up. The graphs of Fig. 5 represent the results of daily routine tests for green bond strength and permeability. A period of deterioration in properties resulting in abnormal high strength and low permeability reached a climax on September 9. This was corrected by increased additions of clay-free sand, and resulted in a steady improvement over the next few weeks.

Core Sands

There is no doubt that the subject of core sands in aluminium alloy founding is very important, and in this respect we are most concerned with that type of core binder which, when mixed with a pure silica sand, which in itself has no bond, produces a mouldable sand which can be baked to form a hard core capable of handling. The supply of these binders seems to rest almost entirely with a few proprietary firms who have specialised in the manufacture of mixtures, each with its own claims of superiority. The majority of these products are mixtures which have been compounded to satisfy the requirements of a good core binder which may be briefly summarised as follows:—

A reasonably economical compound which will easily mix with sand to form a readily mouldable core mixture. It must not dry off too quickly and must bake easily, without distortion, into a durable core which can be handled without fear of damage and which will resist erosion by the flow of molten metal. It should not absorb moisture in storage and not generate too much gas at molten metal temperature. After the casting has solidified the core must collapse readily as the metal contracts.

Obviously this is a formidable list of essentials and one must, in justice, give credit to most of the proprietary mixtures of linseed oil, starch, dextrine, molasses, etc., by saying that they comply generally with the requirements.

It is possible, however, that many of the core binders commonly used for aluminium alloy sand casting are capable of considerable improvement. There is scope for a considerable amount of joint research between the foundry metallurgist and the producer of core binders on such work as, for example, the gas content of cores for aluminium founding. Many troublesome cases of gas porosity and blowholes have been traced to the generation of excess gas in cores or the insufficient venting thereof, and this ever-present problem of venting is obviously influenced by the amount of gas released.

It is probable that the development of synthetic resins as core binders will give considerable improvement in this direction. Many American foundries

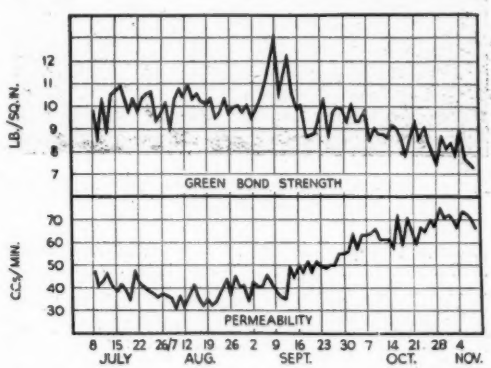

FIG. 5.—ROUTINE CONTROL GRAPH FOR MOULDING SAND.

have reported the successful use of synthetic resin core binders, and manufacturers are beginning to turn their attention to similar application in this country. There is no doubt that the greater collapsibility of this type of core would be a great advantage for light alloy casting, especially for the magnesium base alloys and

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those aluminium base alloys such as D.T.D. 300 and D.T.D. 304. It is possible also that the problem of inhibiting chemical action between magnesium alloys and the moisture of moulding sands would be eased by the use of synthetic resins.

Generally speaking, that part of the routine work of technical control concerned with core sands, is

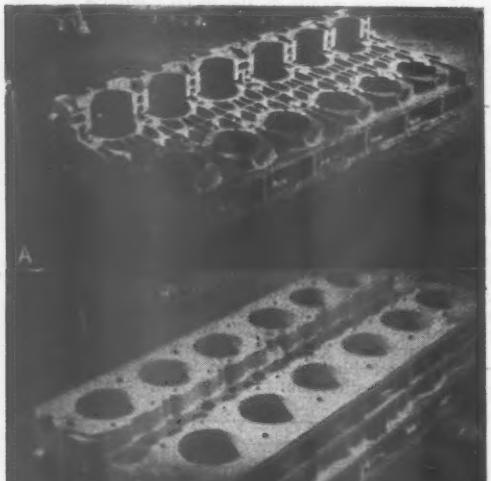

FIG. 6.—"SABRE" CYLINDER BLOCK. (A)—SECTIONED; (B)—COMPLETE.

confined to supervision of the amount of core binder additions and core-baking temperatures. Frequent testing of core sand for mechanical properties with occasional chemical analysis as checks on core-binder consignments are very desirable, so that the quality and uniformity of sand in the core shop may be maintained.

It is a short step from core-making to core-baking. There is no doubt that many of the troubles of gas porosity and blowholes encountered only too frequently in light alloy founding can be attributed to indifferent core-baking. Core binders, as already discussed, are complex chemical substances and the processing, although only a simple baking operation, should be carried out with the care and accuracy the material deserves, bearing in mind that the fate and quality of an expensive casting depends often more on the core than on the mould. A core will liberate about eight times its own volume of gas when the casting is poured. It is known that insufficient core-baking will greatly increase this quantity, although much experimental work remains to be done on core-baking times and temperatures to ascertain optimum conditions. Experience shows that baking with the temperature controlled to close limits in a properly designed circulating air oven is well worth while.

The core-maker should regard core venting as one of the most important parts of his job, as it can be stated with confidence that indifferent core venting is directly responsible for a large proportion of the blowholes and gas porosity troubles of the aluminium foundry.

In the "Sabre" cylinder block, which is shown sectioned in Fig. 6A, and complete in Fig. 6B, there were 184 cores having a total weight of 225 lb. This mass of core-sand material is capable of generating 20 cub. ft. of gas. The importance of providing easy venting for such a volume of gas can easily be imagined. It is equally important to connect up vents through the core assembly and out through the walls of the mould.

FIG. 7.—EFFECT OF INEFFICIENT CORE VENTING.

The effects of inefficient core venting are illustrated in Fig. 7. A section of a casting with an almost entirely enclosed core is shown on the left. On the right are portions of radiographs which show how a blow from the core has developed, causing leakage through the wall of the casting.

The Mould

To pass on in logical sequence from moulding sands and core sands, one must consider the moulding operation. Here, in spite of all attempts at mechanisation, the moulder is still a craftsman in his own right, and in this sphere it is a most delicate task to combine theoretical reasoning with practical application. The technician realises only too well that in hand moulding or machine moulding, with hand rammer or Sand-slinger, milled sand or heap mixed sand, the moulder still retains the power to make or mar the job from

the time he dusts his pattern until the metal fills the risers.

The actual art of moulding is, of course, almost entirely the craftsman's own prerogative, but there are one or two applications in which technical development has endeavoured to assist. For example, there are mould and core coatings. Specially prepared mixtures of fine refractories and binders with liquid bases which can be flame dried or burned off are available to help the moulder to produce better surface finish to his castings. The choice of the most suitable of these dressings and its correct application can best be made by co-operation between moulder and technician. The application of a smooth glaze-like finish to cores will lessen the liability to blow, provided the venting is adequate. Likewise the natural permeability of the mould face may be decreased by mould coating and therefore vents must be provided for blind ends or deep cavities to obviate back pressure. This is an instance where technicians have attempted to supply a medium of improvement for the sand-moulding operation, but they depend for success on the practical man's disposition to apply it in the proper manner.

Whilst on the subject of treatment of mould faces, a point of interest is the treatment of mould faces with oil or paraffin. This appears to be a practice passed down to light alloy founding from ironfounding. Generally speaking, it is to be deprecated on account of its liability to cause gas porosity and/or blowing when casting aluminium, but it is only fair to state that cases have been known where it has been successfully used to combat scabbing without ill-effects. No doubt the oil vaporises and forms an air cushion between the mould face and the molten alloy. It appears to be a practice which can be applied successfully to thin-section castings by expert moulders who can limit the degree of oiling accurately, but the indiscriminate application of this procedure cannot be advocated.

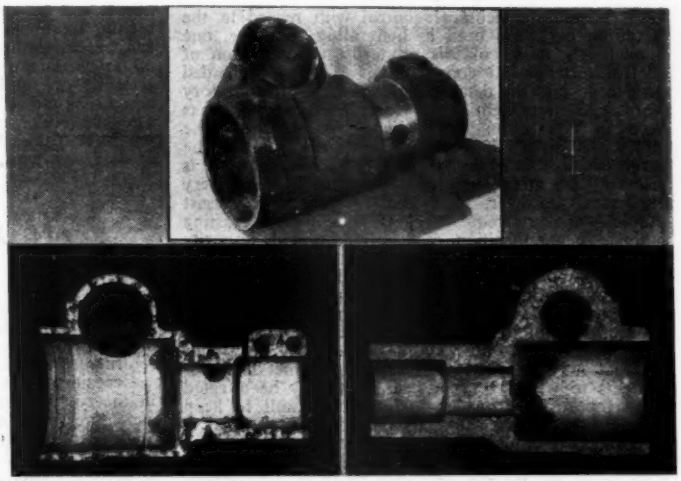

FIG. 8.—(UPPER) CRACKED CASTING; (LOWER LEFT) ETCHED SECTION SHOWING COARSE GRAIN SIZE; (LOWER RIGHT) SECTIONED CASTING SHOWING SATISFACTORY STRUCTURE.

Use of Chills

The use of chills may be a last resort in that ever-present problem of creating a satisfactory scheme of solidification for any light alloy sand casting under review, but their use is nevertheless frequently indispensable. All too often the provision of chills comes almost as an afterthought when the job is being moulded, and the practice of using any odd lump of cast iron for the job cannot be deprecated too strongly. When a moulding method has been established and chills found necessary, then the set of chills should be regarded as a standard part of the equipment, with the position of each chill clearly marked on the pattern. The design of chills is worthy of consideration, the thickness being varied in proportion to the section of the casting to which it is applied or the extent of the chilling required. The importance of chill thickness is often overlooked in an anxiety to provide sufficient surface area, yet the chilling influence is proportional to the total mass of the chill metal, and not to the surface area covered. The design of the face which comes into contact with the molten alloy is especially important. Chill blowing is a well-known hazard and, in principle, large flat surface chills are to be avoided. The best type of surface appears to be a serrated one like the face of a rasp or file. With such a surface there is an opportunity for steam or gas generated to escape along the bottom of the "V" section serrations.

Chill coats such as iron oxide, french chalk, etc., are useful to prevent condensation of moisture on the chill, but it is very important that chills are kept free from accumulations of these coatings, rust, oil or any other foreign matter.

Mould drying, and especially skin drying, is of considerable interest, especially with regard to light alloys, for numerous occasions have been known in making components which appeared to be critical as regards gas porosity where the proper application of this part of mould making was essential. A fixed time and temperature by oven baking is very desirable, for then the job can be standardised. Mould drying apparatus is very good and satisfactory drying may often be

obtained by rigging gas burners within the mould; several mould sections can often be skin dried simultaneously by this means. All standard or semi-standard methods are superior to the torch drying which is often carried out very indifferently by one of the boys in the foundry.

Much has been heard in recent years of electrical radiation drying by infra-red, but it is considered that the principle of this process is rarely suitable or adaptable to the skin drying of sand moulds.

Metal Condition

In considering technical control with regard to the condition of alloys used in light alloy founding, one immediately thinks of this primarily as a question of control of chemical composition. It is not intended here to go into the details of this branch of laboratory work. As most light alloy work in recent years has been in connection with aircraft construction, the alloys used are made to close specification limits. The verification of chemical composition of the alloys is primarily the metal supplier's responsibility. It is very important, however, that the foundry metallurgist should keep a frequent check on current casting samples for composition, especially as regards impurity metals. Modern high-strength casting alloys allow of very little contamination, for these affect both the casting qualities and the mechanical properties of the cast component. However, it is more the physical conditions of aluminium alloys which affect the work of the foundryman and the foundry metallurgist. Ingot material may be correct as regards its metallic constituents to within 0.1 per cent., but may be affected by gas porosity or excess oxide. It is well to keep constant check by section samples of raw material.

Storage conditions and care in transporting aluminium ingot are important, for material allowed to corrode or get wet by exposure may result in gas porosity and certainly will increase fluxing and refining operation troubles during melting. The type of alloy and its condition govern the measures taken in melting to produce metal which will give a sound casting. Most of the alloys are given a fluxing, degassing and grain-refining treatment as a precautionary measure, even if it is not known to be essential.

Fine grain size, which is essential if maximum strength is to be ensured, is obtained by various means. Some alloys, such as the Hiduminium RR series, contain a grain-refining element such as titanium. A supplementary treatment during melting is by plunging into the molten alloy salts of boron. This treatment is somewhat similar to the modifying treatment of high-silicon alloys with sodium or sodium salts, whereby the formation of coarse primary silicon constituents is prevented.

The importance of grain refinement is illustrated by Fig. 8. The top picture shows a casting which cracked extensively when attempts were made to cut a screw thread. The photographs below (left) of an etched section show the coarse grain size which was a contributory factor to the failure, and (right) of a sectioned casting before machinery, having a satisfactory structure. The modification process is essential to the casting of high silicon alloys such as Hiduminium 10 or L.33 if maximum mechanical properties are to be obtained.

In melting a high-magnesium alloy such as Hiduminium 90 or D.T.D.300, a special protective flux, similar to that used for magnesium alloys, must be used to restrict the rapid surface oxidation which would otherwise occur. The moulding sand for this alloy must contain an inhibitor such as boric acid and sulphur or ammonium bifluoride to prevent reaction between the alloy and the moisture in the sand.

Everyone connected with the sand foundry is well aware that all these points on sand conditioning and melting treatment are important, but, once defined, they can be maintained as a matter of routine. They lead up to consideration of the casting itself and there is certainly no routine monotony in the task of devising correct moulding design for light alloy sand castings. The method of running and risering must be planned separately for each component according to the features of its design with the type of alloy used.

(*To be continued.*)

AN UNUSUAL WASTER

By "CORONER"

Usually, when a casting passes the vigorous examination of the foundry casting inspector, it is considered satisfactory, as the majority of inspectors are careful not to pass any doubtful castings which may be returned after a while as defective.

Occasionally, however, a blemish cannot be detected in the rough casting and it is only revealed after an expensive machining operation has been performed. Such a case occurred some time back, in which, in the bore of a fairly complicated cylinder block, a piece of foreign material was found in the form of an "H." This looked very much like the section of a moulder's stud, but, even if one of these were used in the bore —a practice disallowed in the foundry—it would appear as a very small patch of foreign material, being only the diameter of the stem and not as described.

Close examination revealed that the cause of the defect was a stud, and that it had been cut in two during machining. But how did it get there?

A careful consideration of the problem revealed that a number of these studs were used in this casting to keep some foot cores in position, and in all probability, when the mould was turned on end for casting, one of these, being iron, fell to the bottom of the mould and was subsequently floated up the cavity forming the bore, by the incoming metal. After which it lodged against the bore core and being surrounded with metal became fused in position. As the area of the two positions touching the bore core was very small, no mark was revealed in the bore on visual examination and this defect was only discovered on machining.

The lesson from this experience is that when a number of studs are used in a mould, to ensure that each of them is firmly secured so that it cannot shift during casting.

CENTRIFUGAL CASTING

The Discussion

A Paper on "Centrifugal Casting," by Dr. L. Northcott, was read recently before a joint meeting of the London branches of the Institute of British Foundrymen and the Institute of Metals, and published in the FOUNDRY TRADE JOURNAL *for February* 13.

THE CHAIRMAN (Dr. Watson) said he thought their expectation of an interesting Paper had been fully realised. The brief summary of centrifugal casting practice they had heard was obviously the result of a considerable amount of work, and they were all very grateful to Dr. Northcott. He posed three questions. First: were all alloys equally suitable for centrifugal casting, or was there a class for which the process would not be recommended? Secondly: the lecturer had pointed out how segregation in some methods of casting caused trouble and that some alloys displayed that defect to a large degree. He had done no casting himself, but had tried centrifuging silver-copper alloys while cooling them slowly, and there was undoubtedly a considerable amount of segregation taking place. Thirdly: it was a small point, but Dr. Northcott had said that vertical casting was used for short, wide castings and horizontal casting was used for long, narrow castings. When was inclined casting used? By interpolation was it for medium sizes and medium lengths?

Segregation

Dealing with these points, DR. NORTHCOTT said he had been loth to discuss segregation because it was an extremely complicated subject, not only in static casting, but in centrifugal casting. So much depended on the alloy and the method of actual centrifugal casting. It certainly was true that in alloys of the copper-lead variety the two metals were liable to separate unless care was taken in casting. In fact, in Germany—and possibly in this country as well—in casting copper-lead alloy liners on steel the practice was to hold the alloy in the crucible for some little time before pouring to permit segregation of lead in the crucible, and lead-rich alloy was poured last so that the tendency for lead to be flung to the outside of the casting was somewhat counteracted. Speaking generally, there was a tendency for centrifugal castings to show less segregation than in ordinary static castings.

In the usual type of alloy the first material to solidify was copper, but as a result of inverse segregation the outside of the casting was usually low in copper. That tendency was partly overcome by centrifugal casting, because the copper-rich solid was thrown to the outside of the casting. It was centrifuged because it was heavier, whereas the remainder of the alloy material was liquid, so that one got a build-up of copper-rich on the outside and that tended to balance the inverse segregation effect.

The inclined rotation of casting was only used for long castings to enable the metal to run down to the far end of the mould. With short castings, spout pouring was reasonably satisfactory to give a good casting. But with very long castings unless one had a trough pourer one had to tilt the mould up a small amount, five or 10 degrees, to get the metal down the mould.

Porosity

DR. A. G. DOWSON asked whether Dr. Northcott could give any explanation as to why porosity occurred. He had had bad unsoundness in other castings, either through gas coming out of solution or through shrinkage cavities and did not quite see how those two were overcome in centrifugal casting, particularly the gas. And yet the figures produced showed a remarkable difference.

DR. NORTHCOTT, replying, said in ordinary casting, unsoundness could only be due to gas or shrinkage cavities. In other words, gas came out of solution to form a hole or, conversely, the metal shrank away from itself to cause a hole. The shrinkage cavity type of unsoundness was certainly less pronounced in centrifugal casting and almost completely absent in ordinary varieties of centrifugal cylinder casting, owing to unidirectional solidification. If one did not get directional solidification, one did get cavities. One only got freedom from cavities of the shrinkage type if one got directional solidification.

On the question of gas in the ordinary static casting, the forces involved were due to gravity. In centrifugal casting the lighter constituents, of which gas was one, were thrown towards the inside or bore of the casting and the heavier part of the material, consisting of the metal, was thrown to the outside. It was possible with an exceptionally porous material for unsoundness to occur, and he had seen samples of bronze, of the phosphor-bronze type with the pin-hole variety of unsoundness. But presuming the liquid metal was reasonably free from gas, shrinkage cavities should be absent and gas cavities much less than usual.

Casting Temperatures

A MEMBER asked if the lecturer could give general comparisons of casting temperatures for casting similar materials by the two methods.

DR. NORTHCOTT said much depended on the particular alloy. There were some alloys which it was desirable to cast hot in any case whatever the method. Generally speaking, centrifugal castings could be cast at a very low temperature. Aluminium alloys could be

Centrifugal Casting

cast at only a few degrees above the melting point owing to the rapid rate of pour. The metal had to go in quickly and there was no delayed feeding like there was in other castings.

Paper Rolls

DR. EVEREST said he did not want to cross swords with Dr. Northcott on segregation, but he had shown a picture of a bronze centrifugal casting with two pipe-like fissures running through to the outer edge and had said these were due to segregation. He had seen just the same trouble in austenitic cast-iron liners. The trouble in this case was traced to the mould dressing which was giving off gas while the casting was solidifying and perforated the thickness of the casting while the metal was sticky. Was not that a possible explanation in the slide shown?

They had been shown slides of wheels which were cracked and drawn at the ends of the spokes. He believed the speaker attributed that to segregation. Surely a centrifugal casting would be subject to the same general principles during solidification as a sand casting? Those defects looked to him like hot-tears. He was wondering if the lecturer had any reason for saying that they were segregations.

At the beginning of the Paper Dr. Northcott had said he would cover the whole field of centrifugal casting, but no mention had been made of some of the more impressive applications of the process. He thought it was interesting to mention that some of the most impressive centrifugal castings made he had seen were those for large paper rolls made in Sheffield. They were, speaking from memory, up to about 36 ft. long, by 4 ft. dia., and were centrifugally cast.

Davis Steel Wheel

There was another point of centrifugal interest on which he had not touched at all. It was many years ago that the Americans came out with the Davis steel wheel for railway work. That was a steel casting and was peculiar in that two types of steel were cast into the mould. They first poured a manganese steel for the rim and, before it had set, they poured in a carbon steel to form the disc of the wheel. This opened up the whole possibility of casting two or more different metals into a structure like that, thus getting the required properties just where they were wanted.

He had also mentioned the German method of putting a bronze lining inside a steel tube by putting bronze turnings into the tube and closing it and spinning it. A similar method was developed in America before the war for making cylindrical liners for severe conditions, particularly for pumping cement. The Americans used a steel tube into which was put some hard cast iron in the form of crushed material; the whole was heated and, when a sufficient temperature was reached so that the cast iron was just molten, the tube was then spun during cooling, giving a uniform hard lining to the tube.

DR. NORTHCOTT, in replying, said he was afraid he was not acquainted with the last variation which had been described. As far as he knew, the Davis steel wheel was not being made now, but, on the other hand, composite castings in tube or ring form were made by centrifugal casting. That was satisfactory and effective. The Germans adopted it extensively during the war owing to shortage of materials.

The photographs he had shown were not hot-tears, but were shrinkage cavities. Hot-tearing had been experienced and would be experienced with very hard moulds. The gas cavities shown were actually in castings prepared in a dry mould free from mould wash. However, they could get that effect quite readily if the original alloy was free from gas, when there was too thick a mould dressing. In that sense he would agree with Dr. Everest. The particular example shown was duct gas in the metal, and they overcame the trouble by degassing the metal first.

MR. CARTLAND asked for more information about the paper drums. They were new to him. What exactly were they and for what purpose were they used? The mention of them had interested him.

DR. EVEREST, with the chairman's permission, explained that the particular drums to which he had referred were suction rolls for paper mills. They were bronze roll shells, generally of about 4-in. wall thickness, and of a total weight up to 30 or 40 tons. After casting they were drilled through with holes all over the surface. They were part of the paper machine in which the water was extracted from the wet pulp, the water being sucked into the body of the roll. In paper machines there were a number of other applications of centrifugal casting. In fact, the firm who made those rolls offered to make some stainless steel dryer drums in the same way.

Vote of Thanks

MR. DAVIS proposed a very hearty vote of thanks to Dr. Northcott for his lecture. In the London area and the south generally they had not seen much of the centrifugal method of casting, but from the lecture it did seem to open up a great future, especially for the foundryman.

After DR. EVEREST had seconded, MR. G. R. WEBSTER, president of the London branch of the Institute of British Foundrymen, said he would like to thank the Institute of Metals for their welcome that evening, and to say that those joint meetings had been a happy and instructive feature of their two institutes for many years and had added to their metallurgical and foundry knowledge.

I.B.F. NEW MEMBERS

Correction

In the list of I.B.F. new members published on January 30, Mr. E. Lumb, of Sagar-Richards, Limited, Halifax, was incorrectly designated as "Die Department—Foreman." This should read, "Die Designer—Draughtsman."

Mechanical Handling in the Foundry*

By W. Morison Philip

This subject is dealt with from the mechanical handling engineer's point of view and not from that of the foundryman. In foundries, there are a great many handling problems which confront the management from time to time, and that is where the mechanical handling engineer can be of assistance. There is great scope for ingenious design.

At the outset he must obtain from the foundryman a complete survey of the operations of the proposed plant, quantities, capacities, conditions of the materials or units at various stages, etc., in order to lay out a comprehensive scheme, which will enable the foundryman to manufacture his product efficiently by having the materials and equipment necessary for his output carried mechanically from point to point throughout the foundry.

Mechanical handling may be described as a means of moving material in units or in bulk, either from point to point or in a continuous process. One finds almost every type of mechanical handling equipment is now used in foundries throughout the different stages of manufacture. For example, in lifting and moving, as distinct from conveying, one finds the overhead travelling crane, the jib crane, the wall travelling crane, the underhung crane with transfer tracks, the overhead runway with electric hoist block, the cupola charging telpher and skip hoist.

Plant Available

On the conveying side, use is found for the belt, the scraper, slat, push plate, mould plate and overhead chain conveyor, the bucket elevator, the swing tray elevator, gravity roller conveyor with both free and driven rollers.

Some foundries are completely mechanised, but the majority cannot conveniently adopt full mechanisation. However, nearly all can usefully incorporate some mechanical handling plant, and it is proposed to touch on the different departments in foundries where mechanical handling has been devised.

The handling problem starts with the unloading of coke, pig, scrap, limestone, sand, etc., placing this in convenient dumps, reclaiming, weighing and feeding to cupolas. The solution depends on a number of factors, such as the layout of site, quantity dealt with and whether delivery is by railway siding or lorry. An overhead crane may span railway sidings and grab or lift the material from the wagons, electric magnets may be used for off-loading the scrap and pig, and bulk sand may be conveyed direct to storage hoppers inside the foundry.

The layout and type of mechanical handling plant are largely determined by site and quantity to be handled. Then when cupola charging is considered, the question arises as to whether weighing takes place on the ground or on the charging stage, as this affects the design of the plant.

Cupola feeding can be done by means of an overhead crane covering the storage dumps, where weighing is done on the stage. Where weighing is done on the ground, a cupola hoist can be used or a semi-automatic skip hoist. A system of runways on ground is sometimes used connected by a short length in the roof of the cage and a loop on the firing floor passing the cupola feed openings and using tipping or bottom opening skips.

The next handling problem arises when the molten metal has to be distributed to the moulds from the cupola spout. Briefly, either the ladles of molten metal have to be taken to rows of boxes on the floor, or the boxes have to be brought near the cupola in succession. Where the metal is taken to the boxes, as in large moulds, an overhead crane or system of runways and swing jib cranes comprise the usual method. On the other hand, where boxes are on a moving mould conveyor, or gravity roller path, a continuous succession of ladles are necessary to give continuous pouring, and this is usually achieved by means of a pouring runway comprising one or more loops to suit cupola layout with a branch track for ladle heating and spare ladles with suitable sliding transfer switches.

Mould Conveyors

The third handling problem is the form of mould conveyor to be used when a continuous process has been decided upon. A simple form is made by using a special robust design of gravity roller conveyor and in most cases the boxes are placed on flat plates to give smooth travel and manually pushed around the system, the tracks being level. When a power-driven mould conveyor is the answer, it has flat cast-iron plates, and experience has shown that these should overlap to form a continuous table and so prevent anyone getting his foot between the plates and also preventing the spillage of molten metal and sand down on the chain and tracks below the plates. The drive is usually of the caterpillar type.

In most of the recent plants a mechanical pusher, or ram, slides the complete box on to a vibrating grid arranged near the mould conveyor; the sand automatically drops through this grid, while the empty box is placed on a conveyor feeding to the moulding machines, by hand if not too heavy, or by the aid of an electric or air hoist if above 50 or 60 lbs.

The next handling problem is the removal of hot castings till they are cool and delivery to the fettling department or Wheelabrators. The most successful method is an overhead chain conveyor with hooked rods about 4 ft. long to hook up the hot castings and take them for a route march, usually in the roof, the conveyor being arranged to dip down at the required position in the fettling department. Automatic tipping

*A Paper read before the South African branch of Institute of British Foundrymen, Col. Grose presiding

Mechanical Handling

skips attached to the chain conveyor are sometimes used, but are inclined to get distorted by the heat. This arrangement permits the fettling shop or Wheelabrators to be located some distance from the knock-out point.

Sand Handling

The chief handling problem in foundries is usually sand conditioning. The most general arrangement comprises a spillage conveyor to collect surplus sand from the end of distributing belts, and spillings from around the moulding machines, this sand being collected on the belt before it receives the hot sand from the knock-out grid and thereby helping to insulate the belt from the hot sand. After receiving the knock-out sand, it is passed through a vibrating screen to remove large pieces of metal, cores, etc. It is then passed through a second screen, usually of the rotary type, to assist cooling. The receiving belt under this screen is arranged with a side discharge magnetic separator.

The sand is then conveyed to a storage hopper or hoppers. These are usually circular in shape and provided with a revolving discharge table at the bottom, fitted with a plough discharging the sand on to conveyors or skip hoists for feeding the mills. An important point in the design of the sand plant is the type of mill used; that is, whether it is of the continuous or batch type. It is generally conceded that for really continuous operation, a continuous mill is better, though it requires a more constant check to see that the correct mixture is being delivered. A batch mill is said to give a more consistent mixture with less checking, but from a mechanical handling engineer's point of view, it is not desirable to introduce a batch or intermittent machines in a continuous process. The question arises of the introduction of new sand, coal dust, bentonite, etc., and this can be done on a continuous basis by having small hoppers fitted with automatic drum measurers with variable adjustment to regulate the rate of discharge as required.

When the sand leaves the mill, it should not be put into an elevator, as, owing to the presence of the binding medium, it is likely to cause trouble and a belt conveyor is usually more suitable to take it to the distribution conveyor. However, an aerator is arranged between the two conveyors to break up any lumps and generally open up the mixture. The prepared sand is now ready for delivery to the hoppers over the moulding machines by means of a series of hinged ploughs.

Hinged Ploughs

Hinged ploughs can be made floor operated by the moulders, but this usually results in unequal filling of the hoppers, and the tendency is to have a platform along the distributing belt and employ a man to see that all hoppers are kept supplied with sand. Any surplus is allowed to pass over the end pulley and down a chute to the spillage conveyor. In some foundries a portion of the conditioned sand is diverted from the end of the distributing conveyor to subsidiary floor moulding of special jobs.

Hoppers receiving sand from the distributing conveyor should not be too large; otherwise sand will be kept there too long and tend to solidify, whereas it should be kept moving in and out. Quadrant type gate valves are usually fitted at the bottom operated by a single bar above headroom.

Another problem is sometimes the transfer of boxes from moulding machines to moulding conveyor, without too much labour being used. During the war, women were extensively employed in foundries and additional equipment had to be devised to eliminate lifting, etc. In one scheme the light overhead runways are arranged adjacent to the moulding machines and each leg curves over the mould conveyor, embracing several plates. In this scheme, the drags are put on first and the boxes closed on the mould conveyor. The lifting and lowering are done by chain blocks with short hand chains and one pull is sufficient to lift the box off the machine.

In another scheme, a jib crane fitted with air hoists does the lifting and swings the boxes on to a U-shaped horizontal gravity roller track, where coring can be done and the boxes closed by means of an overhead runway, which is carried over the mould conveyor for a short distance so that a vacant space can be found for the completed box. On heavy work, where cranes are used for drawing and closing of boxes, it is usual to design the unit for creeping speed on the first notch of the controller.

Another part of the foundry, where the engineer can often assist the foundryman, is the handling of core sand and the cores to and from the drying oven. In Britain it is usual to pass the sand through a continuous rotary dryer, then up an elevator to a storage hopper arranged over a suitable mixer located on an elevated platform. The mixture is then distributed to the various chutes over the core-making tables arranged at each side of the elevated platform. Cores are then placed on an overhead chain conveyor arranged underneath this platform and taken to the core dryer, which can be located some distance from the actual core-making platform. Core dryers are of several types and the handling engineer designs the layout to suit the type most favoured by the foundry concerned.

Finished cores, after inspection, have still to be taken close to the moulding machines, and this is done by an overhead chain conveyor arranged with carriers made into a series of shelves carrying a large number of cores slowly past the moulding department, this conveyor being taken up into the roof when it leaves this department [A photograph was shown of such a conveyor in a motor foundry at Coventry.]

It will be gathered that the handling engineer can eliminate, or at least alleviate, some of the foundryman's troubles, but it calls for close co-operation between them, as economies can be made in the building and excavation work by collaboration with the mechanical handling engineer at the early stages. The natural development of the foundry industry calls more and more for this close co-operation.

There are the specialists who design the machines for moulding, milling, melting and all the multitudinous processes that the casting of metals entails, and, to co-

ordinate the functions of these machines and processes, is the job of the mechanical handling engineer who specialises in handling materials only, but must co-operate with the foundryman to get the full output obtainable if these machines are to be used to their full advantage. The mechanical handling engineer is only concerned with output, the quality of the production being a matter for the designers of the manufacturing machines and the ability of the foundryman to use them.

Too often one finds that the foundryman is so keen on the making of his castings, getting the building started, and the machines ordered, that he may consult the firm of mechanical handling engineers when all the plant has been arranged for and the building erected. He then finds that many problems in handling, essential to his output, have to be considered, which should have been part and parcel of the whole conception. Overlapping and improvisation are unavoidable in this way, and also "over-mechanisation."

It should not be overlooked that the handling plant must be carefully balanced with the type of product, and the value of it, for one can mechanically equip a foundry to such an extent as to make it uneconomical to run. On the other hand, the aim should be to keep the product constantly flowing, to avoid men walking about the plant, to assist the physical effort of the operators and to eliminate waste of effort or of material.

DISCUSSION

The President (Col. W. Grose) thanked Mr. Philip and declared the Paper open for discussion.

MR. LION CACHET said the Paper reminded him of an evening several years ago. Some members might remember how they discussed the general foundry in South Africa. A foundry was sketched on the blackboard and they went on to mark all the operations the moulder and general operator had to undertake in order to produce a casting. It was assumed that 4-in. tie pieces were being produced. Each time the weight of the casting or its equivalent was lifted by hand, they made a white mark, a red mark indicating that the weight of the casting was lifted by power. The meeting was in full agreement at every step. At the end of the discussion they found that 120 tons of material had been lifted to produce one ton of castings, but only 15 times had mechanical power been used.

Ways and means of improving this position were discussed, and various suggestions were made. He felt that Mr. Philip had now given the answer. He had demonstrated how castings could be made without back-breaking labour. On the other hand, he had not explained how to make castings in a general jobbing foundry. There were many difficulties to be resolved. A mass production foundry presented fewer difficulties in regard to mechanisation than the general foundry, which comprised the largest section of the industry in South Africa. During the war they had opportunities to make castings in larger quantities than before, and it was possible that in future quantity production would be possible to a greater extent Yet in South Africa, as in any other country, the industry would still be faced with a large tonnage of jobbing work.

Mr. Cachet recalled that at the beginning of the year he had an opportunity to visit foundries in Britain and found that the methods used in some of them compared unfavourably with conditions in the Union. South African foundries had more modern plant and buildings, while the sunshine made them less grim. On the other hand, he saw several establishments such as Mr. Philip described. The type of industry depicted in the Paper was run by the mechanical handling engineer, the chemist and the sand expert. In such conditions the foundryman ceased to exist. It should be realised, however, that in a young country like South Africa the amount of handling was disgraceful. Yet the industry had reached its present position despite the amount of labour wasted through bad handling and planning. It was high time modern plant and conditions were introduced. Recent developments had shown the possibilities of manufacture for foundries in South Africa. The country already had several fully mechanised foundries and probably there would soon be more. In most cases, however, it was necessary to find the golden mean between over-mechanisation and under-mechanisation, the ideal being to make the fullest use of mechanisation that was economically possible.

Steel Foundries

A MEMBER was very interested in the problem of mechanisation in steel foundries. He referred to the last example shown by Mr. Philip, depicting a steel-foundry in which the boxes were brought to the pouring station by a power-driven mould conveyor. He pointed out that in a steel furnace there was probably about 2½ hrs.' duration between charges and two or three tons of metal coming from the furnace. How could a belt be kept moving continuously throughout this period?

MR. PHILIP explained that the foundry shown in the photograph had two furnaces, one being a melting furnace, feeding at intervals into the other, which was a holding furnace. The holding furnace could be tapped continuously. Using only one furnace, a hold-up was inevitable.

Subsequently MR. SNOW asked whether any type of conveyor with intermittent movement had been developed, which could be used in steelfoundries where no holding furnace was provided.

MR. PHILIP said that this presented no difficulties. There was no reason why a conveyor should not be made to move any given distance, cut out, and start again at any predetermined time.

MR. BILL (recently transferred from the East Midlands Branch) congratulated Mr. Philip on his excellent general description. Very good progress had been made in Britain, particularly during the war, in the semi-mechanisation of jobbing plants. From experience, he considered that bottom plates were not always necessary with gravity roller conveyors. What Mr. Philip had said about the return conveyor from the spillage tied up with his later remarks on over-mechanisation. He agreed that over-mechanisation was fatal. He had once seen a particular conveyor which averaged an accident a week. Eventually it was scrapped and a steel band installed, which proved much more satisfactory.

Mechanical Handling

Incidentally, a steel band was probably the best means of transporting green cores. He was surprised that Mr. Philip had given no bouquet to the vertical continuous stove, which had revolutionised core production, and could dry cores weighing anything from ½ oz. to 1 cwt. in the same oven at the same rate. He considered that a vibratory knockout was the most satisfactory, since it did not destroy the boxes, but removed all the sand from the boxes. The only drawback was that, if there were any brittle castings, it was liable to break the actual castings, but it was in his opinion much superior to the rocking type in common use here.

On the subject of hydraulic or pneumatic push-offs, MR. BILL pointed out that the Paper made no mention of the tipping plate, which did away with any extra mechanisation. He was of opinion that the rotary magnet was the most successful means of removing tramp iron, but that it was necessary to provide a tailing chute to remove most of the larger tramp iron. He considered that the rotary screen was infinitely better than the flat vibrating type. The type of sand mill depended on the type of sand, the production called for, and the type of casting. Personally, he preferred a batch type mixer. He agreed that ploughs were the best means of removing sand from belts.

Air Hoists

Referring to air hoists for moving moulds from the machine to the casting conveyor, MR. BILL said he had had little success with them, but had never tried them on large boxes With small boxes there was almost invariably a jolt at the end of the lift. The ordinary chain hoist was far too slow. The photograph of the track link foundry reminded him of a plant where there was an ingenious method of taking boxes from the machine by a balanced cantilever, which women could operate quite comfortably. The easiest way of getting the core sand to the machine was by an overhead platform with a wheelbarrow. Mr. Philip had not shown any core-sand drier, and he wondered what was the most suitable type. Finally, a point which he regarded as being of paramount importance was that a mechanised plant needed just as much supervision as a jobbing foundry. Everything had to be controlled.

Magnetic Separators

MR. PHILIP, in reply, said that with a gravity conveyor the question of having plates underneath depended largely on the size and weight of the box and the type of casting. Some foundries used them while others did not. Core stoves were special machines designed by specialists and not by mechanical handling engineers. As regards the ram at the knock-out, several ideas had been tried. His company favoured a ram and found a double ram more satisfactory than a single one. He had no experience of a tipping plate mentioned by Mr. Bill, but had no doubt it was quite a good one.

The magnetic separator should not be expected to take out big stuff, and in all very modern plants it was arranged after the rotary screen and all it had to take out were the small sprigs, etc., which got through the two screens. On the subject of batch and continuous mills, every foundryman had his own idea. As regards the plough idea, if there were 15 fixed ploughs distributing sand, it was better to pay one man's wages to look after this problem The receiving hoppers under the distributing belt must have at least one vertical side. The main point was that they should not be too big. He found an air hoist the quickest method and, where speed was a consideration, would usually prefer it. However, he considered that chain hoists, when specially designed, were quite quick. It would not be policy for him to recommend any particular unit. He had shown a photograph of a rotary drier in action.

MR. BILL described one of the most interesting sand driers he had seen, in which the draft through the drier not only drew hot air through the sand, but also took away the fines, thus eliminating the dust, which was one of the biggest nuisances.

As an indication of the divergence of opinions on the subject of foundry plant, MR. LAWS referred to an American expert, who was entirely opposed to rotary magnets, considering that they were liable to cause damage to the conveyor belt. He also mentioned the rack type of hoist preferred by some foundrymen, and expressed the opinion that any air hoist could close without a jolt if carefully operated.

Before closing the meeting, the President paid tribute to the late Mr. Nimmo Dewar, one of the foundation members of the Branch.

BEDFORD FOUNDRY APPRENTICESHIP SCHEME

W. H. Allen, Sons & Company, Limited, of Queen's Engineering Works, Bedford, have set out in a mimeographical document of foolscap size, an excellent system of apprenticeship for moulders. The reason, apparently, for choosing this not too suitable format is urgency, because associated with the scheme is the offer of bursaries.

These take the form of paying, for a period of two years, lodging allowances to six boys. Moreover the firm will pay the cost of weekly attendance at the Borough Polytechnic in London, for receiving instruction in foundry practice. Further, the firm will pay travelling expenses for the boys to go to Bedford to inspect the laboratories and foundry. The closing date for applications is March 8. Perhaps owing to the fuel crisis the firm will be good enough to extend this a little for those belatedly reading this article.

THE TRUSTEES OF THE Lawrence Ennis Memorial Scholarship Fund, which was set up by the directors of Dorman, Long & Company, Limited, in 1940 as a memorial to the late Mr. Lawrence Ennis, have awarded scholarships for 1946 to five employees. Normally a scholarship will be awarded annually to one young man who has completed full apprenticeship with the company and attained a high standard of efficiency in both theoretical and practical work throughout his apprenticeship. Grants were, however, postponed during the war.

Ceramic Coatings for Steel in High-temperature Service*

By W. N. Harrison, D. G. Moore and J. C. Richmond

Early in the war, supplies of many materials were inadequate to meet essential war demands. Nickel and chromium were particularly scarce because of the greatly increased demand, and also because the normal importation of these metals was endangered.

To alleviate this situation, a project was undertaken at the National Bureau of Standards, which included: (*a*) development of special heat-resistant ceramic coatings for low-carbon steels, which could then be substituted for nickel-chrome steels in many applications, and (*b*) testing of the new coatings in direct comparison with the conventional type of glossy porcelain enamels, as exemplified by those used on the exhaust manifolds of some motor-car engines.

Some of the new coatings gave superior test performance, and were described in a report to the armed services dated June, 1943. The present Paper comprises extracts from that report and supplementary information on service tests, compositions, and the use of the coatings in production of parts for the armed services. A more detailed report is published in the Journal of Research of the National Bureau of Standards.[1]

Development of High-temperature Coatings

In order to avoid the necessity for extremely high smelting temperatures, conventional ground-coat frits were used, and refractoriness of the coatings was increased by mill additions. Zirconium oxide, titanium dioxide, ferric oxide, aluminium oxide, chromic oxide, silicon dioxide, silicon carbide, feldspar, mullite and chrome ore were added in various amounts, both singly and in combinations.

These coatings were milled, applied, and fired by the methods used for porcelain enamels. The specimens were then examined for surface texture and adherence. Those that showed promise were heated for short periods at 900 deg. C. in order to obtain an indication of their resistance to deterioration at high temperature. Of the various coatings tested, those containing alumina gave the best results.

It was found that the type of alumina used, greatly influenced the properties of the coating. In general, alumina calcined at low temperatures produced the most desirable coatings, and A-1 alumina, as produced by the Aluminium Ore Company, was finally selected as well suited for the coatings in view of its properties and availability.

In the early development work, it was noted that alumina had a powerful effect in raising the resistance of the coatings to flow at elevated temperatures. To obtain more specific comparisons, a representative "hard" ground-coat frit was dry-ground to a fineness such that about 1 per cent. was retained on a number

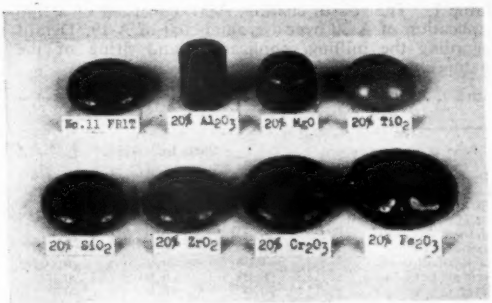

FIG. 1.—EFFECT OF 20 PER CENT. ADMIXTURES OF VARIOUS OXIDES ON THE FUSION PROPERTIES OF A "HARD" PORCELAIN ENAMEL GROUND-COAT FRIT WHEN PREPARED AS CYLINDERS $\frac{5}{8}$ IN. DIA. BY $\frac{3}{4}$ IN. HIGH AND FIRED FOR 10 MINS. AT 870 DEG. C. NOTE SHARP EDGES REMAINING ON SPECIMEN CONTAINING ALUMINA.

200 sieve and, at the same time, a number of refractory admixtures were ground to approximately the same fineness. Mixtures were prepared from the resulting powders in the ratio of 80 per cent. of frit to 20 per cent. of oxide by weight, and cylinders $\frac{5}{8}$ in. in diameter were dry-pressed. After drying, these cylinders were reduced to a uniform length of $\frac{3}{4}$ in. The cylinders were fired for 10 mins. at 870 deg. C., then cooled slowly to room temperature.

Fig. 1 shows the results of these tests. The frit (No. 11), with no addition, fused to a button, while the same frit with an admixture of 20 per cent. by weight of A-1 alumina maintained its original sharp edges. The other oxide admixtures were not particularly effective

* A Report issued by the National Bureau of Standards, U.S. Department of Commerce.

Ceramic Coatings for Steel

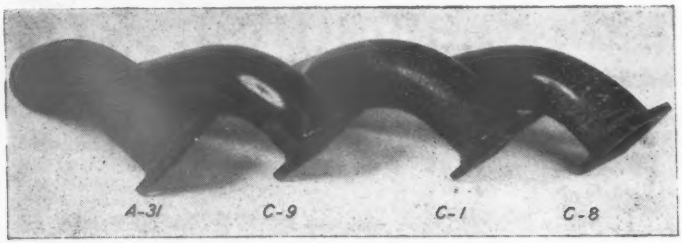

FIG. 2.—PHOTOGRAPH OF 4 COATED STEEL EXHAUST STACKS AFTER 178 HRS. ON A 1,350-H.P. RADIAL MOTOR UNDERGOING BLOCK TEST OPERATION. COATING A-31 ON THE LEFT IS ONE OF THE HEAT-RESISTING COMPOSITIONS DEVELOPED AT THE N.B.S., WHILE C-9, C-1 AND C-8 ARE 3 COMMERCIAL COATINGS SUBMITTED FOR TEST.

in reducing the high temperature flow of the frit. The relatively large size of the buttons with chromic oxide and iron oxide admixtures was caused by a bubble structure, and indicates a gas-forming reaction during the firing operation.

Four of the coatings prepared with A-1 alumina were outstanding in their effectiveness, appearance, adherence, and ease of application.[2] The mill batches for these coatings (A-19, A-20 and A-55m) are given in Table I. The fourth coating, A-31, consisted of a thin application of A-20 over a ground-coat of A-19. Details regarding the milling, application, and firing of the coatings are given in reference 1.

TABLE I.—*Mill Batches Used in the Preparation of Ceramic Coating A-19, A-20 and A-55m.*

Ingredient.	Parts by weight.		
	A-19.	A-20.	A-55m.
Frit I*	50.0	—	—
Frit II	50.0	100.0	100.0
Calcined alumina†	25.0	20.0	15.0
Enameller's clay	10.0	6.0	15.0
Black cobalt oxide ..	1.00‡	0.25‡	0.50‡
Citric acid crystals ..	0.05	0.05	0.03
Water	50.0	50.0	50.0

* The ratio of the soft frit (No. 1) to the hard frit (No. II) may be varied in either direction when the resulting slip is better suited to local plant conditions. Compositions of frits I and II and detailed instructions for application may be found in reference No. 1.

† Aluminium Ore Company's A-1.

‡ This amount of cobalt oxide may be reduced or even eliminated without damage to performance characteristics. The nearly black colour imparted by the cobalt is conducive to uniformity of appearances.

The following tabulation gives the coefficient of linear expansion per deg. C. over the range 25 to 400 deg. C., and also the interferometer softening temperature of frit No. 11 and of three coatings.

Material	Expansivity 25–400 deg. C.	Interferometer Softening Temperature
Frit 11	9.6×10^{-6}	531 deg. C. 988 deg. F.
Coating A-55m ..	9·6	560 ,, 1,040 ,,
Coating A-19 ..	10.2	589 ,, 1,092 ,,
Coating A-20 ..	10.3	592 ,, 1,098 ,,

The thermal expansion is higher for the new coatings than for many ground-coat enamels. Experience has shown, however, that these new coatings should not be applied in as great a thickness as conventional ground-coat enamels, because of a tendency of thick applications toward spontaneous chipping, a defect

FIG. 3.—SHOWING CONDITION OF 2 COATED STEEL EXHAUST STACKS AFTER 300 FLYING HOURS ON 3 PBM-3D PATROL BOMBER. STACK ON LEFT IS PROTECTED WITH N.B.S. CERAMIC COATING A-31 AND IS UNDAMAGED, WHILE STACK ON RIGHT, WHICH IS COATED WITH COMMERCIAL ENAMEL C-1, SHOWS SCATTERED BROKEN BLISTERS AND SERIOUS RUSTING AT THE RESULTING BREAKS IN THE COATING.

FIG. 4.—SECTIONS OF COATED STEEL COLLECTOR RINGS AFTER OPERATION ON A 450-H.P. 9-CYLINDER CONTINENTAL MOTOR UNDERGOING DYNAMOMETER TESTS. THE PART ON THE RIGHT, WHICH WAS PROTECTED WITH ONE OF THE POOREST CONVENTIONAL ENAMEL COATINGS, HAS UNDERGONE 13½ HRS. OF TEST AND SHOWS PRONOUNCED CHIPPING AND CRACKING OF THE COATING. THE PART ON THE LEFT IS PROTECTED WITH THE N.B.S. CERAMIC COATING A-31 AND HAS UNDERGONE 120 HRS. OF TESTING ON THE SAME MOTOR WITHOUT CRACKING OR REBOILING. THE AREA WITHIN THE CIRCLE WAS CLEANED OF GREASE AND OTHER EXTERNAL DEPOSITS, SHOWING THE UNDAMAGED COATING BENEATH.

which ordinarily indicates an excessively high residual stress between the coating and metal base. This higher residual stress in the ceramic coatings may be caused by the higher softening temperatures, resulting in a wider temperature range over which stress is introduced into the ceramic coatings during cooling.

All of the matte coatings prepared with A-1 alumina were somewhat porous, and it is believed that this porosity is responsible for the absence of reboil blisters when coated specimens are heated through the range 565 to 670 deg. C. The reboil gases are apparently able to pass through these porous coatings without blistering, while the imperviousness of the dense glossy types is such as to prevent the escape of these same gases without formation of blisters.

Laboratory Tests of Coatings

Numerous laboratory tests were made on the coatings developed at the National Bureau of Standards as well as on conventional type coatings submitted for trial by a number of manufacturers. The laboratory test conditions were chosen to simulate operating conditions in aeroplane exhaust systems, especially stacks and collector rings of some motors without turbo-superchargers, and included the following: (*a*) flame-impingement test; (*b*) three types of thermal shock test (two very severe); (*c*) test for protection of metal against oxidation, and (*d*) test for the protection of metal against changes in properties caused by heating. The flame-impingement and thermal shock tests caused cracks in varying degrees in all the conventional type coatings and also produced reboiling in these coatings during the heating. The cracks occurred in patterns suggesting strain lines, and the reboiling tended to follow the cracks, but also occurred in random distribution where there were no cracks. Neither defect occurred in the N.B.S. ceramic coatings A-19 or A-31.

The coatings which showed the least reboil gave the best protection to the metal against oxidation, and also proved most effective in preventing loss in strength and the development of embrittlement.

Service Tests

A considerable number of exhaust stacks, coated at the National Bureau of Standards, were attached to motors and tested by the Philadelphia Naval Air Experiment Station, the Norfolk Naval Air Station, the Army Air Technical Service Command at Wright Field, the Bell Aircraft Corporation, the Glenn L. Martin Company, and the Wright Aeronautical Corporation. Collector type exhaust systems were tested by or under supervision of the Army Ordnance Tank Automotive Centre, the Navy Department Bureau of Aeronautics, the Aeronca Aircraft Corporation, and the Grumman Aircraft Engineering Corporation.

One of the first sets of exhaust stacks to be tested is illustrated in Fig. 2, which shows their condition after 178 hrs. of operation on a 1,350-h.p. motor at the Naval Air Experiment Station in Philadelphia. Coating A-31 shows no effect from the treatment, while coatings C-9, C-1 and C-8 (all glossy ground-coats) are damaged in varying degrees. Two types of defect are present on the damaged stacks. One is a series of cracks following a design apparently corresponding to the strain lines caused by temperature gradients. The second defect consists of reboil blisters, which broke and exposed the metal beneath. Such blisters have a tendency to segregate along the cracks. In areas where no cracks are formed they show no definite pattern. These defects closely resemble those found in

Ceramic Coatings for Steel

the laboratory tests; in fact, there was excellent correlation between the several service tests and the laboratory tests.

Fig. 3 shows two stacks after 300 flying hours on a Martin PBM-3D patrol bomber operating out of Norfolk, Va. The A-31 stack (on the left) is not visibly affected by the treatment, while the stack on the right coated with C-1 shows numerous broken blisters and serious rusting.

All the other service tests also showed the newly developed coatings to be superior to the conventional glossy coatings. In no case did the A-19 or A-31 coatings develop visible cracks or reboiling. Because A-19 is applied in one coat, while A-31 requires two, A-19 was recommended for exhaust stack applications. Where metal temperatures of 675 deg. C. or slightly above are encountered, A-31 is recommended, but low-carbon steels have so little strength at these temperatures that the uses are limited.

Fig. 4 shows sections from two of a series of coated collector rings tested under the supervision of the Tank Automotive Centre of the Army Service Forces. These collectors were attached to M-4 tank motors during dynamometer tests. The part on the left was coated with A-31, and had undergone 120 hrs. of operation. The other coating, which was one of the poorest, was a proprietary product of the glossy type, and had been under test for 13.5 hrs., or only about one-tenth as long as the specimen coated with A-31.

Proving ground tests were also made on 10 collector rings, each of which was protected with a different coating. One of these collector rings was coated with A-19 at the National Bureau of Standards, and the others were coated by seven enamel frit manufacturers, to whom the uncoated collector rings had been submitted by the Tank Automotive Centre for application of coatings recommended by these manufacturers. After approximately 2,500 miles of operation on N-4 tanks, only the N.B.S. ceramic coating received an "excellent" rating.[3] The others all showed damage, most of which consisted of thermal cracks and blisters.

Production of Coated Exhaust Parts

Commercial production of low-carbon steel exhaust stacks with N.B.S. ceramic coating A-19 was started in 1944. By the end of the war three enamelling companies had applied the coating to substantial quantities of aircraft exhaust stacks. Since the shortage of stainless steel never became acute enough to limit its use in aircraft, the A-19 coating on low carbon steel was used through preference rather than through an enforced substitution.

Another application of the A-19 coating which reached the production stage before the end of the war was the coating of tail pipes for the exhaust systems of the amphibious truck or "duck." One section of this pipe was 9 ft. long by 1¾ in. inside diameter, with S-shaped curves at each end. Two other sections were approximately 3 and 2 ft. long, respectively, with 2½ in. inside diameter. It is considered significant that the coating could be applied satisfactorily to such complex shapes. These pipes were originally fabricated of uncoated low-carbon steel, and failed rapidly in service, through corrosion. Not only high operating temperatures, but also proximity to, and contact with, ocean water contributed to the corrosion. Tests showed that coating A-19 provided good protection.

Potential Uses of Coatings

In addition to the use of the new coatings for the protection of low-carbon steel in various military exhaust systems, there are a number of other possible applications where the new coatings, or modifications thereof, might be beneficial in prolonging the life of steel parts which are subjected to relatively severe temperature conditions. A list of such potential applications would include the following: (1) domestic stove parts such as grates or burners; (2) industrial furnace parts, such as muffles, dampers or burners; (3) parts for heat interchangers; (4) heat baffles for continuous enamelling furnaces; (5) annealing boxes, and (6) mufflers and tail pipes for 'buses, lorries and motor-cars.

REFERENCES.

1 W. N. Harrison, D. G. Moore, and J. C. Richmond, "Ceramic Coating for High-temperature Protection of Steel," J. Research N.B.S., Vol. 38, March, 1947. (Reprint of this Paper may be secured from the Superintendent of Documents, Washington 25, D.C.)

2 Because of the unusual properties of these coatings, application was made for a Government patent. This application was originally filed under the provisions of Revised Statute 4814, which served to keep the subject matter in a confidential category. At the end of the war the need for these restrictions no longer existed and the patent application was released from this status in December, 1945.

3 The performance of these coatings in both laboratory and service tests led to the preparation of appropriate specifications. These were issued as Army-Navy Aeronautical Specification AN-C-133, and as tentative specification AXS 1449 of the Army Ordnance Department.

FIRST F.B.I. REGIONAL CONFERENCE ON INDUSTRIAL RESEARCH

The Federation of British Industries is to sponsor a series of regional conferences on industry and research, and the first will be held at Birmingham on Tuesday, March 25, 1947. Principal speakers will be Sir Edward Appleton, F.R.S., Secretary of Department of Scientific and Industrial Research, Sir William Larke, Chairman of F.B.I. Industrial Research Committee, and Sir Peter Bennett, M.P., Chairman of F.B.I. Midland Regional Council. The general subject to be discussed will be the application of science by industry, and the part research can play in promoting industrial efficiency, exports, and a higher standard of living, with special reference to industrial problems in the Birmingham area. Special attention will also be given to the smaller manufacturing concern which cannot afford the cost of a research department, and to the research organisations and facilities which could serve it. The conference will be held at the Queen's Hotel, and admission will be free to all interested. Further information may be obtained from the F.B.I. Industrial Research Secretariat, 21, Tothill Street, S.W.1.

ALUMINIUM HOLLOW-WARE PRICES

The Aluminium Hollow-ware (Maximum Prices) Order, 1947, which came into operation on February 3, fixes maximum prices for home-produced aluminium hollow-ware. On a sale by a wholesaler, the price is to be that paid to the manufacturer plus 25 per cent. (in the case of hollow-ware marked "H" or "C," 17.65 per cent.). Retail sales are to be made at the price paid to the manufacturer or wholesaler plus 50 per cent. The wholesaler who does not maintain a regular selling organisation and carry substantial stocks may add only 5 per cent. to the price paid by him.

The Order also fixes maximum prices for imported aluminium hollow-ware at the landed cost and 30 per cent. thereof (50 per cent. on a sale to a retail customer) in the case of an importer or a wholesaler; and in the case of a retailer the price paid to the importer or wholesaler and 50 per cent. thereof.

Marked "H" or "C" means so marked in accordance with the provisions of Article 4 of the Hollow-ware and Kitchen Hardware (Control of Manufacture and Supply) Order, 1947. This new Order consolidates the Hollow-ware and Kitchen Hardware (Control of Manufacture and Supply) Orders, numbered 4, 5, 6 and 7, with amendments. Under it, the prohibition of the manufacture and supply, except under licence, of aluminium hollow-ware is removed; but such goods may not be supplied unless marked—(*a*) with a mark notified by the Board of Trade, and (*b*) with certain special letters in the case of drawn hot-plate ware and cast ware ("H" and "C" respectively).

The total value of the controlled goods specified in Part II of the First Schedule and parts thereof supplied by a manufacturer without a licence—(*a*) between February 3 and March 31, 1947, together with the total value of such goods supplied between October 1, 1946, and February 3, 1947, and (*b*) in a six-monthly period beginning on April 1 or October 1 in any year, may not exceed £1,800.

Hearth furniture, except coal hods, is expressly excluded from the goods controlled under this Order.

CONFERENCE ON MECHANICAL PROPERTIES OF SOLIDS

The University of Bristol, in co-operation with the Institute of Physics, is arranging a Summer School in Theoretical Physics, with special reference to cohesive forces in metals and the mechanical properties of solids, to take place from July 2 to July 5 next. Lectures will be given by members of the staff of Bristol University, including Prof. N. F. Mott, F.R.S. The course will be followed by a conference from July 7 to July 9 at which Papers on the experimental and theoretical aspects of the subject will be given by research workers from this country and abroad. Particulars relating to the Summer School may be obtained from the Secretary, the Institute of Physics, 47, Belgrave Square, London, W.1, or from the Director of the Department of Adult Education, The University, Bristol.

COUNCIL ON SCIENTIFIC POLICY

The Lord President of the Council has appointed the following to serve on the Advisory Council on Scientific Policy which, as announced in the House of Commons recently, has been set up to advise him in the exercise of his responsibility for the formulation and execution of Government scientific policy:—

Sir Henry Tizard, chairman; Sir Edward Appleton, secretary, Department of Scientific and Industrial Research; Sir Alan Barlow, Treasury; Sir Howard Florey, Professor of Pathology, Oxford University; Sir John Fryer, secretary, Agricultural Research Council; Sir Claude Gibb, managing director, C. A. Parsons & Company, Limited; Sir Edward Mellanby, secretary, Medical Research Council; Sir Edward Salisbury, Director, Royal Botanic Gardens, Kew, and secretary of the Royal Society; Sir Ewart Smith, Imperial Chemical Industries, Limited; Sir Reginald Stradling, chief scientific adviser, Ministry of Works; Prof. A. R. Todd, Professor of Organic Chemistry, Cambridge University; Dr. A. E. Trueman, deputy-chairman, University Grants Committee; Prof. S. Zuckerman, Professor of Anatomy, Birmingham University.

The council will be served by a small scientific secretariat in liaison with the secretariat of the Defence Research Policy Committee.

UNITED KINGDOM TIN POSITION

The Ministry of Supply has released the following figures showing the United Kingdom tin position for the month of December:—

	Ministry.	Consumers.
	Long tons.	Long tons.
TIN METAL:		
Stocks at December 1	8,464	4,090
Arrivals	—	—
Production	2,447	—
	10,911	4,090
Deliveries:		
To U.K. consumers 2,192	—	2,192
For export 940	3,132	—
		6,282
Consumption	—	2,152
Stocks at December 31	7,779	4,130
TIN ORE (Tin content):		
Stocks in U.K. at December 1	9,253	
Stocks in U.K. at December 31	8,947	

* Calculated. Reported 3,683 tons.

DORMAN, LONG'S £2,000,000 CONTRACTS

Dorman, Long & Company, Limited, are supplying the structural steelwork and other materials for three new power stations and for extensions to 13 existing power stations in connection with the programme of expansion of electricity generating capacity in Great Britain. Approximately 35,000 tons of structural steelwork alone is involved. The total value of the contracts is about £2,000,000.

OBITUARY

MR. THOMAS RUSSELL, a former manager of the Coltness Iron Company, Limited, has died at the age of 88.

MR. HENRY G. M. DEAS, a partner in the firm of John Deas & Company, engineers and ironfounders, of Glasgow, has died suddenly.

MR. ARTHUR THOMAS PEACOCK, a director of Peacock & Waller, Limited, mechanical engineers, of Hinckley, Leics., has died at the age of 70.

MR. URQUHART FRASER BURRELL, head of the firm of A. R. Brown, M'Farlane & Company, Limited, iron and steel merchants, of Glasgow, and a director of Glasgow Chamber of Commerce, died recently.

MR. ROBERT STOREY, joint managing director of the Storey Foundry Company, Limited, Stockport, has died after a long illness. Together with his brother, Mr. J. E. Storey, he established the company in 1919.

MR. HECTOR FRASER MACINTOSH, who was for nearly 30 years secretary of A. F. Craig & Company, Limited, engineers, ironfounders, etc., of Paisley, died recently. He joined the company in 1897, and retired a year ago.

MR. JOHN HAMILTON HARVEY, who was for many years a director of William Hamilton & Company, Limited, shipbuilders and repairers, of Port Glasgow, has died at the age of 84. He retired from business 25 years ago.

MR. HARLAND WALSHAW, blast-furnace manager at the Scunthorpe Works of John Lysaght, Limited, for the past 25 years, died recently at the age of 69. He commenced his career with the Frodingham Iron & Steel Company, Limited. Before joining John Lysaght, Limited, in 1922, Mr. Walshaw was blast-furnace manager to a number of companies.

MR. WILLIAM LINDSAY CARLOW, chairman and managing director of D. M. Stevenson & Company, Limited, iron, steel and scrap merchants, etc., of Glasgow, died recently following a long illness. He was born at Leven in 1882 and joined the company some 40 years ago. He was a director of the Shotts Iron Company, Limited, and other companies.

CAPT. HENRY FITZHERBERT WRIGHT, who died recently, was appointed to the board of the Butterley Company, Limited, in 1902. Following the death of Mr. A. Leslie Wright, Capt. Wright was appointed chairman of the company in 1938, which position he held until he retired on account of ill-health in 1944. He was 76 years of age. Capt. Wright was M.P. for North Herefordshire from 1912 to 1918.

MR. ROBERT GREAVES BLAKE, who has died at the age of 71, was managing director of Stephenson, Blake & Company, Limited, type founders, and a director of Thomas Turton & Sons, Limited, steelmakers, etc. Until recently he was a director of the Staveley Coal & Iron Company, Limited, and of the Cannock Associated Collieries, Limited. He was formerly a director of George Butler & Company, Limited, and Kayser, Ellison & Company, Limited.

STEEL INDUSTRY RECRUITMENT

The British Iron and Steel Federation has produced a fast-moving sound film, "Iron and Steel," to give an insight into the industry for the stimulation of recruitment of young metallurgists and engineers. The documentary, which runs for approximately 30 minutes, is specially designed for use in schools, colleges and universities, and as a general interest film. It traces the historic development of steelmaking, maintaining interest with brief explanations of the technical processes involved, illustrated by striking action shots of Siemens and blast furnaces, and large, continuous hot-rolling mills in operation. The locations used in making the film include:—Colvilles, Limited, Glasgow; Appleby-Frodingham Steel Company, Limited, Scunthorpe; Dorman, Long & Company, Limited, Middlesbrough; the Lancashire Steel Corporation, Limited, Warrington; Thos. Firth & John Brown, Limited, Sheffield; Guest, Keen & Nettlefolds, Limited, Birmingham; English Steel Corporation, Limited, Sheffield, and N. Hingley & Sons, Limited, Dudley.

SHIPYARD HOURS' PROPOSALS ACCEPTED

A joint conference of the Executive Committee of the Shipbuilding Employers' Federation and the Shipbuilding Group Council of the Confederation of Shipbuilding and Engineering Unions has reached agreement on the hours to be worked in the shipbuilding and ship-repairing industry. The recommendation of the Ministry of Labour court of inquiry on shipyard hours was adopted, and a 5½-day week of 44 hours is to be in force during the months of November, December, January and February, and a 5-day week of 44 hours during the remaining eight months of the year.

CONSUMPTION OF NON-FERROUS METALS

Detailed figures of consumption of non-ferrous metals in the United Kingdom during the fourth quarter of 1946 have been issued by the Directorate of Non-ferrous Metals. Consumption of virgin metal in each quarter of 1946 was as follows (in tons):—

	Total 1946.	First quarter.	Second quarter.	Third quarter.	Fourth quarter.
Zinc	216,089	50,653	51,548	53,865	60,342
Lead	193,506	55,426	48,013	45,913	44,150
Tin	25,606	5,421	6,449	6,593	7,143
Cadmium ..	542	129*	138	144	131
Antimony ..	5,623	1,490	1,260*	1,529*	1,344

MR. T. B. SANSOM, of Bruce Peebles & Company, Limited, in a lecture to the Scottish Engineering Students' Association, stressed the need for organised training arrangements for apprentices and students of engineering.

MR. JOSEPH WILLIAM WILSON, chairman and managing director of James Austin & Sons (Dewsbury), Limited, iron and steel stockholders, etc., for the past 24 years, has died suddenly. He had been associated with the company for over 50 years.

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SPECIFICATION

WEIGHT	80-90 lbs.
Length	22 inches
Width	8½ inches
Thickness	3¼ inches

(at notch 2½ inches).

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STANTON, HOLWELL & RIXONS BRANDS

THE STANTON IRONWORKS COMPANY LIMITED NEAR NOTTINGHAM

NEWS IN BRIEF

LINSEED OIL has been increased in price by a further £65 per ton to £200.

THE BOARD OF TRADE announce that the token import arrangements have been extended to Italy.

THE PRICE OF home-produced deadburnt magnesite has been reduced to £14 10s. per ton delivered.

TANGYES, LIMITED, announce that the address of their London office is now 60, Grosvenor Street, W.1 (telephone: Mayfair 1338).

AFTER A LAPSE of several years, iron-ore imports are being resumed at the Hartlepools. A cargo of 1,280 tons has arrived from Caen.

SIR DAVID MAXWELL FYFE, K.C., M.P., will be the chief guest at the jubilee dinner of the Institution of Production Engineers next Tuesday.

METROPOLITAN-VICKERS, LIMITED, and an associated company are to take over the Ministry of Supply clothing department at Motherwell.

THE LONDON ADDRESS of the American Chamber of Commerce is now 7, York Buildings, Adelphi, W.C.2 (telephone: Temple Bar 4804).

SOUTH SHIELDS CORPORATION have approved plans for the erection of a factory on the Bede estate for Crushing Screening & Engineering, Limited, Newcastle-upon-Tyne.

THE FEDERATION OF BRITISH INDUSTRIES is to sponsor a series of regional conferences on industry and research, the first of which will be held at Birmingham on March 25.

TWO NEW BRANCHES of the American Foundrymen's Association have been established at Denver, Colorado, and Tulsa, Oklahama. The latter is to be known as the "Tri-City Chapter."

IRISH STEEL, LIMITED, Haulbowline, Co. Cork, has been offered for sale as a going concern. The products of the company are protected by a duty of 37½ per cent. (25 per cent. preferential).

DORMAN, LONG & COMPANY, LIMITED, have converted the large hall, formerly the home of Middlesbrough Exchange, into a spacious drawing office for their central engineering and plant construction departments.

THE MARCO CONVEYOR & ENGINEERING COMPANY, LIMITED, have opened a new office at 3, Bond Street, Hockley, Birmingham, 19. The office, which is under the direction of Mr. G. H. Taylor, is complete with drawing office staff.

THE U.S. FEDERAL RESERVE BOARD'S seasonally adjusted index of industrial production for December is 179. While both iron and steel output declined in December because of strikes, steel early in January recovered to peak rates.

A PRIVATE LETTER from Mr. P. B. Parks, foundry manager to the Hong Kong & Whampoa Dock Company, Limited, states that the works are now being reconstructed after suffering damage from over 400 bombs during the Japanese invasion.

CLARKE CHAPMAN & COMPANY, LIMITED, have received an order valued at about £3,000,000 for the supply of six large water-tube boilers for the Poplar (London) generating station. The company's order-book is reported to be the heaviest on record.

A DEMONSTRATION OF the process of flame cutting was held at the Edmonton works of the British Oxygen Company, Limited, recently. The latest machines now in use are able to penetrate to a depth of 4 ft. and this was successfully accomplished in a block of mild steel at a cutting rate of 1½ in. per min.

JOHN BROWN & COMPANY, LIMITED, have been given the monopoly for the manufacture in Great Britain of the closed-cycle gas turbine for marine and land services. The turbine will be manufactured under licence by Escher Wiss Engineering Works, Limited, Zurich. John Brown & Company will also manufacture the Escher Wiss variable pitch propeller.

AT SUNDERLAND QUARTER SESSIONS, the Recorder upheld the appeal of Joseph L. Thompson & Sons, Limited, shipbuilders, etc., against the decision of Sunderland Assessment Committee not to recognise half an acre of land at the shipyard as an industrial hereditament. The land, it was stated, was used for marking materials used in the shipyard and the Recorder said this should be distinguished on the valuation list.

BLAW-KNOX, LIMITED, British Ropeway Engineering Company, Limited, Butters Bros. & Company, Limited, John M. Henderson & Company, Limited, Frederick Parker, Limited, and Stothert & Pitt, Limited, have received orders for about £400,000 of plant from the Zezere Hydro Electric Company, of Portugal. The plant is in connection with the construction of the Castelo do Bode dam, about 100 miles North-east of Lisbon.

MR. DAVID BROWN, managing director of David Brown & Sons (Huddersfield), Limited, has acquired the whole of the share capital of Aston-Martin, Limited, motor-car manufacturers, and it is intended that the company's activities should continue at Feltham, Middlesex. Mr. Brown will be the chairman and managing director of the company, while Mr. R. G. Sutherland and Mr. C. Hill will remain on the board as technical directors.

THE PHOSPHOR BRONZE COMPANY, LIMITED, Birch Road, Witton, Birmingham, 6, announce that the directorate, as the result of new appointments, is now comprised as follows:—Mr. J. L. Hardy (chairman); Mr. G. T. Hyslop and Mr. W. Smithson (joint managing directors); Mr. C. V. McNeill (sales director); Mr. E. H. Powis (director); Mr. D. L. Roome (director and secretary); Mr. F. R. Wix (director); and Mr. A. N. Wormleighton (director and cost controller).

MR. JAMES DAVIDSON, retired iron and steel merchant, of Giffnock, died last month.

MR. EVERARD JAMES RANDALL, of Dronfield, died recently at the age of 68. He for many years represented the Glacier Metal Company, Limited, of Wembley, Middlesex.

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PERSONAL

MR. W. L. HARRIS has resigned from the board of Silentbloc, Limited.

MR. GEORGE MORRISON has been appointed general manager of the Greenock Dockyard Company, Limited.

MR. ANDREW KERR, shipping commercial manager, has retired after 58 years' service with the Carron Company.

DR. ERIC ALTON has now commenced business as a consulting engineer and metallurgist at 14, Park Lane, Sheffield, 10.

MR. J. LIVESEY, B.Sc., A.M.I.Mech.E., has been appointed works manager of Glenfield & Kennedy, Limited, Kilmarnock.

MR. HUGH D. BUTCHART, chairman of Tullos, Limited, engineers, of Aberdeen, has retired. He is succeeded MR. T. HUTCHISON.

MR. P. A. PETERSON has been appointed a director of J. Stone & Company, Limited, engineers and non-ferrous founders, of Deptford, London, S.E.14.

DR. F. W. HAYWOOD has been appointed to the board of Wild-Barfield Electric Furnaces, Limited, as technical director. He joined the company in 1938 as chief metallurgist.

MR. JEAN LOBSTEIN, president of the International Committee of Foundry Technical Associations, has changed his address to La Cour Normande, 4, route de Montigny, Cormeilles-en-Parisis (S. & O.).

MR. D. J. STRUTT has retired after more than 37 years with the British Thomson-Houston Company, Limited. He was commercial engineering representative of the company in the Midlands for many years.

MR. B. C. EVANS, chairman and joint managing director of Veritys, Limited, who has completed 55 years' service with the company, has resigned from the board. He is succeeded as chairman by MR. C. J. PITT, managing director. Mr. Evans' services are being retained in an advisory capacity.

MR. F. L. SMITH has been appointed chief technical engineer in charge of the central engineering department of Dorman, Long & Company, Limited, while MR. H. C. CRONK has been appointed chief engineer of the plant construction department. Formerly with H. A. Brassert & Company, Limited, Mr. Smith assisted in the construction of the Corby Works of Stewarts and Lloyds, Limited. Mr. Cronk was previously on the staff of Richard Thomas & Baldwins, Limited.

MR. W. C. FAHIE has resigned his position of head of the instrument section of the physics department of the British Iron and Steel Research Association. He is to take up an appointment in the Ministry of Defence. MR. S. S. CARLISLE, who has been appointed to succeed Mr. Fahie, joined the Association last October after four years' service in the experimental department, H.M.S. Excellent, Portsmouth, on the staff of the Director of Scientific Research, Admiralty.

MR. WILLIAM M. GOOD, following his resignation from the Brush Electrical Engineering Company, Limited, and Heenan & Froude, Limited, last year, has now resigned from Associated British Engineering, Limited, and has also ceased to be a director of Fielding & Platt, Limited, Court Works, Limited, Industrial Waste Eliminators, Limited, Associated Locomotive Equipment, Limited, Hyganic Developments, Limited, Wellesley Holdings, Limited, and the New Destructor Company, Limited. With these resignations he has now completed the severance of his interests from those of his brother, Mr. Alan Paul Good. MR. F. S. MITMAN, who resigned the managing directorship of the Brush Electrical Engineering Company, Limited, last year, has now also resigned from Associated British Engineering, Limited.

NEW TRADE MARKS

The following applications to register trade marks appear in the "Trade Marks Journal":—

"PIREKS"—Carburising boxes; metal parts of furnaces; annealing trays and containers, etc. DARWINS, LIMITED, Fitzwilliam Works, Templeborough, Sheffield.

"ASTEX"—Plaster for use in foundries for making patterns, moulds and cores. HARBOROUGH CONSTRUCTION COMPANY, LIMITED, Harbilt Works, Logan Street, Market Harborough.

"EUTECTOR"—Chemical flux compositions for use in welding, brazing and soldering. EUTECTIC WELDING ALLOYS COMPANY, c/o Albert L. Mond & Thiemann, 14-18, Holborn, London, E.C.1.

"TILBLAST"—Sand, shot and sludge blast machines for the scouring of metals; scouring and abrasive preparations. TILGHMAN'S PATENT SAND BLAST COMPANY, LIMITED, Atlantic Street, Broadheath, Altrincham, Ches.

COMPANY RESULTS

(Figures for previous year in brackets.)

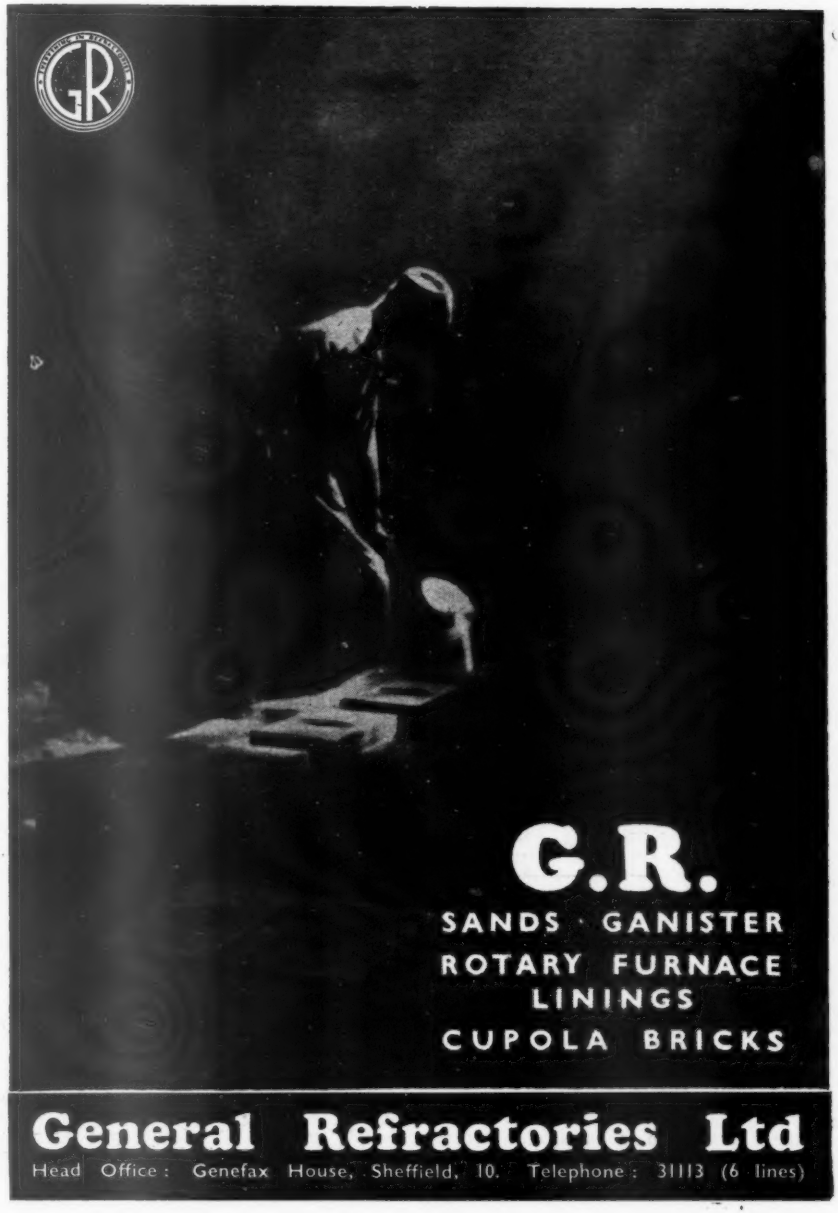
Airscrew Company—Final dividend of 15%, making 25% (same) and interim dividend of 10% (same) on account of the current year.

Benton & Stone—Net profit to August 3, after taxation, etc., £21,772 (£17,899); final dividend of 10%, making 15%, tax free (same); to general reserve, £10,000 (£5,000); forward, £13,690 (£11,206).

John Bolding & Sons—Net profit for 1946, after bad debts, depreciation, tax, etc., £20,032 (£16,728); final dividend of 12½% (10%), making 17½% (14%); to pensions, £3,500 (£2,500); general reserve, £6,253 (nil); forward, £39,733 (£39,079).

Weyburn Engineering Company—Profit for the year ended October 31, after providing for depreciation, etc., £19,223 (£26,907); estimated amount recoverable in respect of E.P.T., £9,000 (nil); to estimated income tax, £14,800 (£19,557); deferred repairs no longer required, nil (£5,000); final dividend of 22½% and bonus of 5%, making 35% (same); forward, £1,771 (£1,818).

WE ARE INFORMED that the report on the German Spun Iron Plants, appearing in our issue of February 6, was made by Mr. J. Curtis of the Stanton Iron Works Company, Limited, and not by Mr. Hallett.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Raw Material Markets

IRON AND STEEL

The Minister of Supply has made the Control of Iron and Steel (No. 57) Order, which came into force on Monday. The Order amends maximum prices, the principal alterations being increases in the prices of hematite pig-iron, Scotch foundry iron, blast-furnace ferro-manganese, bright steel bars, galvanised sheets, wire rope, nails, and commercial hot-finished seamless tubes. Ferro-alloys and high-speed steel are removed from price control.

More than normal interest will be focused on the statistics of iron and steel production for the month of February. The present impression is that the industry has weathered the storm with only minor casualties. Distribution of output has been held up by the embargoes on heavy goods traffic, but the coal trains have been coming through fairly regularly and actual stoppages of production—confined chiefly to the rolling mills—have been less extensive than were originally foreshadowed. Nevertheless, there has been some loss of production which will ultimately have its effect on the steel consuming industries. Ominously, the Government's "Economic Survey for 1947" refers to the possibility of industrial frustration through lack of steel and indicates the cutting of steel exports to the minimum to maintain "the precarious balance" of home supplies.

"Black February" has exposed a weakness inherent in the concentration of foundry pig-iron production in the Midlands. Since the bulk production of No. 3 Cleveland G.M.B. pig-iron was abandoned, foundries on the North-East Coast, and to some extent in Scotland, have been dependent for supplies on Midlands blast furnaces. Under the strain of recent months it has been impossible to keep the supply lines open. Deliveries of foundry pig have been held up and stocks at the foundries have dwindled almost to vanishing point. Obviously, their replenishment is dependent on the restoration of heavy goods traffic, which is still precarious. Happily, the output of pig-iron does not appear to have seriously diminished, but at best it was barely adequate for current needs and short supplies will inevitably have an adverse effect on the production of builders' and engineers' castings at a time when these products are in most urgent demand. Heavy establishments have also been hampered by short deliveries of coke and there have been a few brief interruptions of operations in the Cleveland ironstone mines owing to the weather and the lack of trucks.

Apart from the lack of fuel and power, the re-rolling industry has been handicapped by the non-delivery of essential tonnages of blooms, billets, etc. As transportation improves, the intake of home-produced steel semis will no doubt improve, but it is manifest that the economy of the industry is based on the import of supplementary tonnages of steel semis, and for some time to come the purchase of overseas supplies is going to be difficult.

Several weeks ago the biggest steel producers in the North of England announced that they were compelled to lay certain mills idle simply because they had no further space available to take undelivered products into stock. The lack of transport has been, in fact, a more serious difficulty than the shortage of fuel and power. However, it is hoped that there may soon be a progressive improvement in this respect and, in the meantime, most, if not all, of the mills are at work. There is no lack of demand. Relatively little outside work has been possible in the shipyards for a month past, but their requirements are heavy. Colliery and railway specifications are also being given special priority, but the White Paper gives a clear warning of their intention to discourage the expansion of other steel consuming industries for the rest of the year.

NON-FERROUS METALS

Under the Control of Non-ferrous Metals (No. 27) (Copper, Lead and Zinc) Order, 1947, which came into force on February 28, the maximum price of copper is increased by £10 per ton. The price of high-conductivity electrolytic copper is therefore raised from £117 to £127 per ton. Prices for other forms of copper are correspondingly adjusted.

The revised licensing procedure for the acquisition of tin metal, as outlined by the Ministry of Supply on January 3, has now been modified. Arrangements have been made by which tin consumers who were unable to obtain cover for tin metal, owing to their holdings being in excess of four months' consumption, may now cover themselves each month to the extent of 90 per cent. of their monthly rate of consumption in the basis period (September and October, 1946) Inquiries should be made to the Directorate of Non-ferrous Metals, 20, Albert Street, Rugby.

U.S. domestic production of copper is well below current demand. Imports are at present practically at a standstill, as the incidence of the 4 cent duty on foreign purchases makes users reluctant to enter into commitments. It is felt that the supply position may shortly become really critical unless the Government decides to suspend or eliminate the duty. Government purchases of foreign copper ended in December last, and estimates suggest that there will be only about 7,500 tons of foreign copper available for March allocation by the Government.

The U.S. domestic price of lead, which is not controlled although there are official restrictions on consumers' inventories, has been raised to 14 cents per lb., New York, an increase of 1 cent.

MIDDLESEX FOUNDRY, LIMITED, is being wound up voluntarily. Mr. S. R. Dunwoody, Ling House, 10-13, Dominion Street, London, E.C.2, is the liquidator.

THE STANDARD BRASS, IRON & STEEL FOUNDRIES, LIMITED, of Benoni, South Africa, have sent us a monthly tear-off wall calendar carrying pictures of a turbine runner, gear wheels and centrifugally cast phosphor-bronze tubes.